DETERMINATION OF GROUND WATER POTENTIAL IN LAGOS STATE UNIVERSITY, OJO; USING GEOELECTRIC METHODS (Vertical electrical sounding and horizontal profiling)

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ABSTRACT: A resistivity survey was carried out to study groundwater potential in Lagos State University (Faculty of Law open field), such as depth, thickness, resistivity and sediment at which water can be obtained. The geo-electrical methods used in the survey are Vertical Electrical Sounding and Horizontal profiling, with the aim of determining which method is best used to determine groundwater potential. Four Vertical Electrical Soundings were conducted using the Schlumberger configuration and Horizontal spread covering the entire area. The VES data were subjected to an iteration software (WIN RESIST) which showed that the area is composed of top soil, clay, sandy clay and sand. The Horizontal Profiling data was also subjected to an iteration software (DIPPRO) which gave the imaging of the lateral variation in resistivity. Based on the interpretation of the two methods, interested layer under the geoelectric section is sand in VES1-4 which signifies a probable aquiferous zone with resistivity range between 206.2Ωm to 406.6Ωm, and thickness from 3.0m to 13.0m. Areas with favourable resistivity and thickness were sand formation along the traverse with resistivity ranging between 226Ωm to 436Ωm. It was observed that there is really no difference between the VES and the horizontal profiling. [Report and Opinion 2010;2(5):68-75]. (ISSN:1553-9873).

KEYWORDS: Groundwater potential, vertical electrical sounding, horizontal profiling

1.0 INTRODUCTION

Groundwater is the largest available reservoir of fresh water. A majority of fresh water is locked away as ice in the polar ice caps, continent ice sheets and glaciers beneath the ground. Water in rivers and lakes only account for less than 1% of the Worlds' fresh water reserves (Environmental Agency, United Kingdom). It is among natural resources bestow the human race. There must be space between the rock particles for groundwater to flow and the Earth's material becomes denser with more depth. Essentially, the weights of the rock above condense the rock below and squeeze out to open the pore spaces deeper in the Earth. That is why groundwater can only be found within a few kilometers of the Earth's surface. Observation shows that groundwater comes from rain, snow, sheet and hail that soak into the ground and become the groundwater responsible for the spring, wells and bore holes (Oseji et al., 2005)

Groundwater is water located beneath the ground surface in soil pore spaces and in the fractures of lithologic formations. A unit of rock or an unconsolidated deposit is called an aquifer when it can yield a usable quantity of water (enikipeda.org/wiki/groundwater). The depth at which soil pore spaces or fractures and voids in rock become completely saturated with water is called water table. Groundwater is often withdrawn for agricultural, municipal and industrial use by constructing and operating extraction wells. Groundwater is also widely used as a source, for drinking supply and irrigation in food production (Zekster and Everett, 2004). Naturally, 53% of all population relies on groundwater as a source of drinking water. In rural areas the figure is higher. Basically, Lagos which is the study area located in the south-west region of Nigeria with dense population living along the coast have a problem with inhabitants gaining access to groundwater at the same depth.

Electrical resistivity method of geophysical techniques happens to be the most preferred method in groundwater potential.

Vertical Electrical Sounding (VES) is a geoelectrical common method to measure vertical alterations of electrical resistivity. The method has been recognized to be more suitable for hydrogeological survey of sedimentary basin (Kelly and Stanislav, 1993).

The electrical resistivity technique involves the measurement of the apparent resistivity of soils and rock as a function of depth or position. The most common electrical technique needed in hydrogeologic and environmental investigations is vertical electrical soundings (resistivity sounding). During resistivity surveys, current is injected into the Earth through a pair of current electrodes, and the potential difference is measured between a pair of potential electrodes. The current and potential electrodes are generally arranged in a linear array. Common arrays include dipole-dipole array, pole-pole array, Schlumberger array and the Wenner array. The bulk average resistivity of all soils and rock influencing the current. It is calculated by dividing the measured potential difference by the input current and multiplying by a geometric factor specific to the array being used and electrode spacing.

In a resistivity sounding, the distance between the current electrodes and the potential electrodes is systematically increased, thereby yielding information on subsurface resistivity from successively greater depth. The variation of resistivity with the depth is modeled using forward and inverse modeling computer software. Geophysical investigations which involve electrical resistivity and shallow seismic refraction methods have been used in the alluvial coastal belt of Digha, in the Eastern India for environmental study, to investigate the nature and status of subsurface saline water contamination (Kalpan et al., 2001).

The vertical sounding method was chosen for this study because the instrument is simple, field logistics are easy and straight forward while the analysis of data is less tedious and economical (Ako and Olorunfemi, 1989). It also has capability to distinguish between saturated and unsaturated layers.

The Schlumberger method has a greater penetration than the Wenner. In resistivity method, Wenner configuration discriminates between resistivties of different geoelectric lateral layers while the Schlumberger configuration is used for the depth sounding (Olowofela et al, 2005). Geoeletric method is regularly used in determination of depth,thickness and boundary of an aquifer (Omosuyi et al, 2007, Asfahani, 2006, Ismail Mohameden, 2005), in determination of groundwater potiential (Oseji et al., 2005), exploration of geothermal reservoirs (El-Qady, 2006) and estimation of hydraulic conductivity of aquifer (Khalil and Monterio, 2009; Yadav, 1995)

1.1 GEOLOGICAL SETTING OF THE STUDY AREA

The study area, Lagos State University, is located in Ojo Local Government Area of Lagos States, Nigeria. The geological setting of the study area reveals that it lies solely within the extensive Dahomey basin, the basin extending almost from Accra to Lagos. Its existence during or before maestricution, area is sedimentary basin whose thickness increases from north to south (down dip) and from east to west. The littoral and lagoon deposit of recent sediment underlies the area. The coastal belt varies from about 8km near the Republic of Benin border to 24 km towards the eastern end of the Lagos Lagoon (Nton, M.E, 2001).

More also, the area consist of sediment of clay, unconsolidated sands and mud with a varying proportion of vegetable matter along the coastal areas while the alluvial deposit consists of coarse claying unsorted sand with clay lenses and occasional pebble beds.

1.2 HYDROGEOLOGY OF LAGOS STATE

Lagos State is basically a sedimentary area located within the western part of Nigeria, a zone of coastal creek and lagoon (Elueze, et al, 2004). The area is also developed by barrier beaches associated with sand deposits (Ogbe F.G.A, 1992). The subsurface geology reveals two basic lithologies: clay and sand deposits. These deposits may be inter-bedded in places with sandy clay or clayed sand and occasionally with vegetable remains and peat. The water bearing strata of Lagos State consist of sand, gravel or admixtures from fine through medium to coarse sand gravel (Adeleye, D.R 1975).

Basically, there are four major aquiferous units that are being tapped for the purpose of water supply in the Lagos metropolis. The first aquifer extends from the ground level to roughly 12m below the ground layers of clay and sand. This upper aquifer is of minor importance for large water supply purposes. This aquifer is prone to contamination because of its limited depth.

The second aquifer is encountered between 20 and 100m below sea level and it can be found around Igando axis.

The third aquifer is encountered in the central part of Lagos at the depth ranging from 130-160m below the sea level.

The fourth aquifer is located at an elevation of approximately 450m below the sea level. It is separated from the third aquifer by a rather thick layer of shale of the Ewekoro formation. Only few boreholes tap water form this aquifer (Jones and Hockey, 1964). The hydrogeology of the study area falls within the first and second aquifer described above.

2.0 MATERIALS AND METHODS

The instrument used in the research work is the ABEM terrameter SAS 1000 Sweden and accessories. The set up contains the ABEM terrameter SAS 1000, hammers, stainless electrodes, cables, paper tape.

The electrical resistivity method was used for the investigation. In all a total of four VES station were surveyed in the study area. All these four stations are all within the campus.

Schlumberger configuration and Wenner configuration were used.

2.1 SCHLUMBERGER CONFIGURATION

A total of four vertical electrical sounding were carried out in the study area. The traverse separation was 3 m. The four traverses are represented as VES1-4. An average spread of 200m (AB) was covered.

2.2 WENNER CONFIGURATION

One horizontal profiling using wenner spread with maximum electrode separation $\left(\frac{AB}{2}\right)$ of 120m, was carried out. ABEM SAS 1000 resistivity meter was used in obtaining the apparent resistivity of each horizontal profiling station.

From the work carried out, the data in table 1.0 data were acquired

3.0 RESULTS AND DISCUSSION

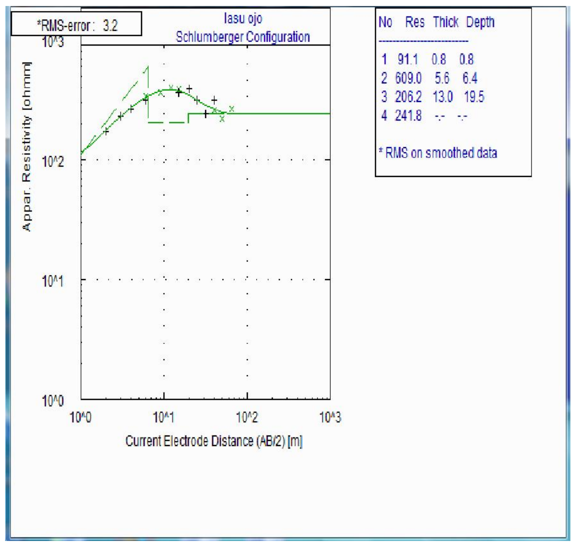
3.1 DATA INTERPRETATION

An iteration software (WIN RESIST) is used to iterate curves of VES1-4 and it is represented in figure 1a-1d. The smooth curves taken through the set of data points were interpreted quantitatively by the method of partial curve matching. Layer resistivity and thickness were gotten from VES1 to VES4 diagram.

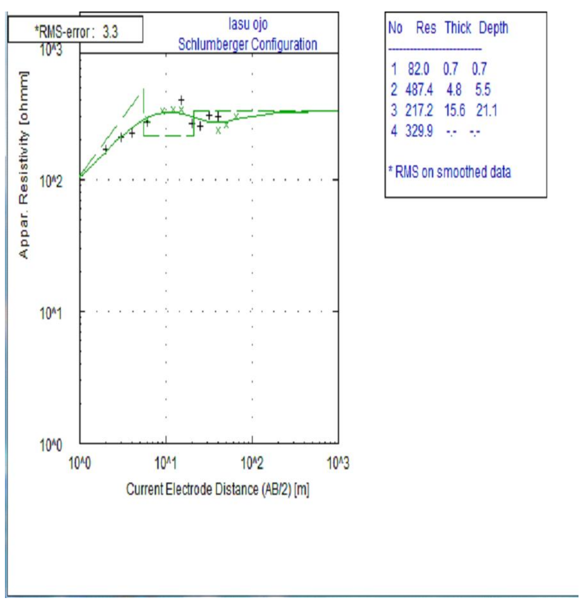
TABLE 1.0

S/N	AB/2 (m)	VES1 ρ(Ωm)	VES2 ρ(Ωm)	VES3 ρ(Ωm)	VES4 ρ(Ωm)
1	1	107.9	117.9	118.0	115.0
2	2	168.8	175.1	178.9	168.7
3	3	211.7	233.8	228.4	214.0
4	4	230.0	269.9	266.9	245.0
5	6	273.6	312.6	313.9	274.2
6	6	285.9	337.0	317.5	251.0
7	9	330.0	365.0	340.9	272.0

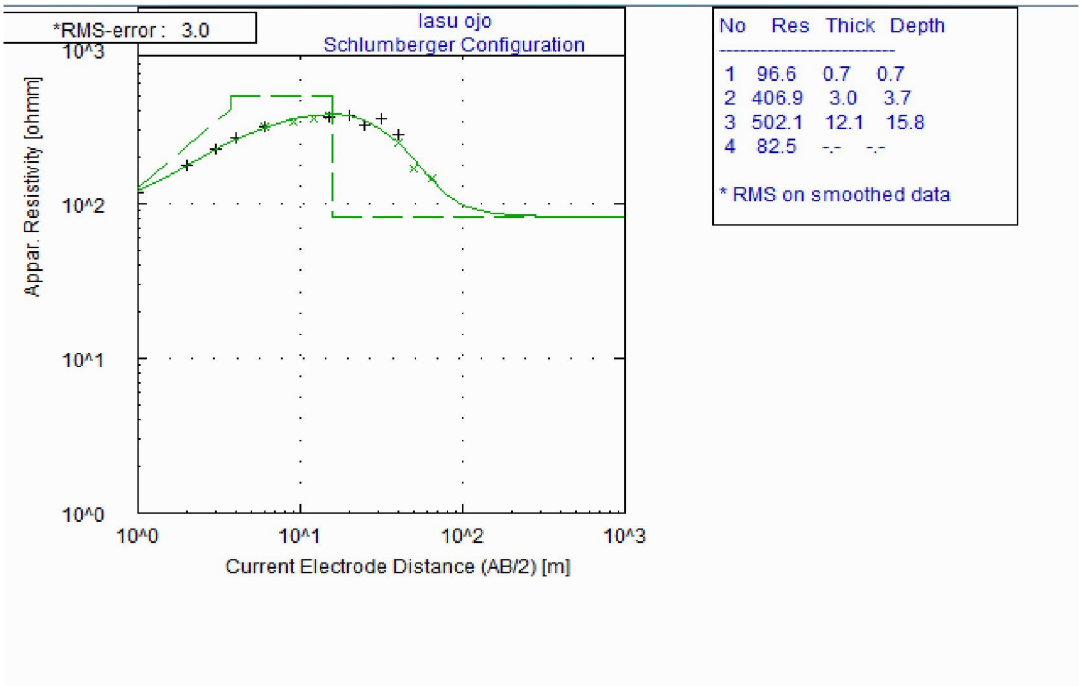
8	12	342.0	401.6	357.0	264.7
9	15	340.0	393.8	370.0	255.0
10	15	400.7	368.7	361.5	317.5
11	20	270.0	330.5	377.0	260.7
12	25	255.0	316.1	326.2	232.1
13	32	311.0	245.0	357.2	213.2
14	40	304.3	317.7	280.5	123.98
15	40	237.0	261.0	247	188.8
16	50	260.0	220.4	168.6	74.92
17	65	300.0	270.0	147	32.4



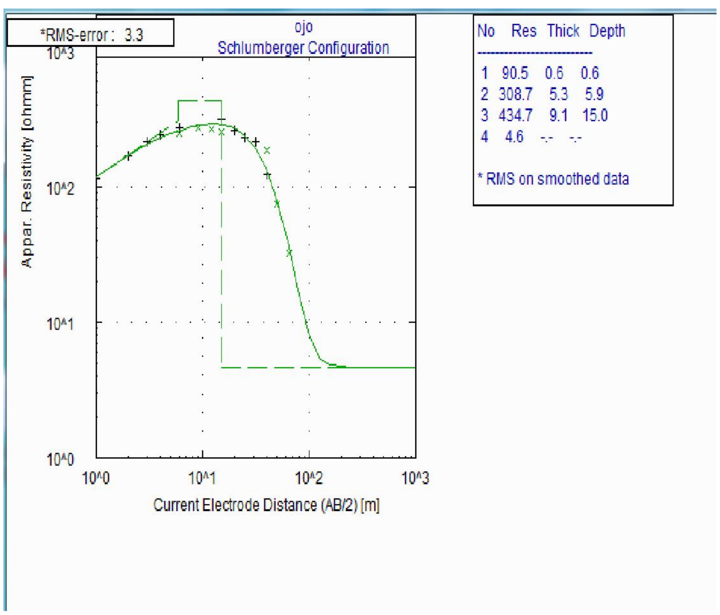
FIGURE; 1a



FIGURE; 1b



FIGURE; 1c



FIGURE;1d

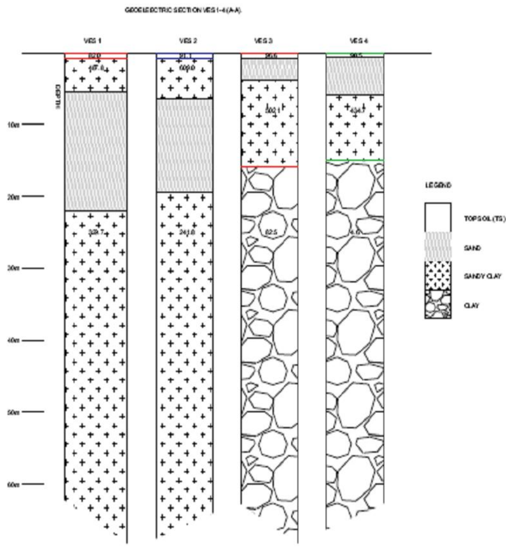


FIG 2.0; Geoelectric Section of Study.

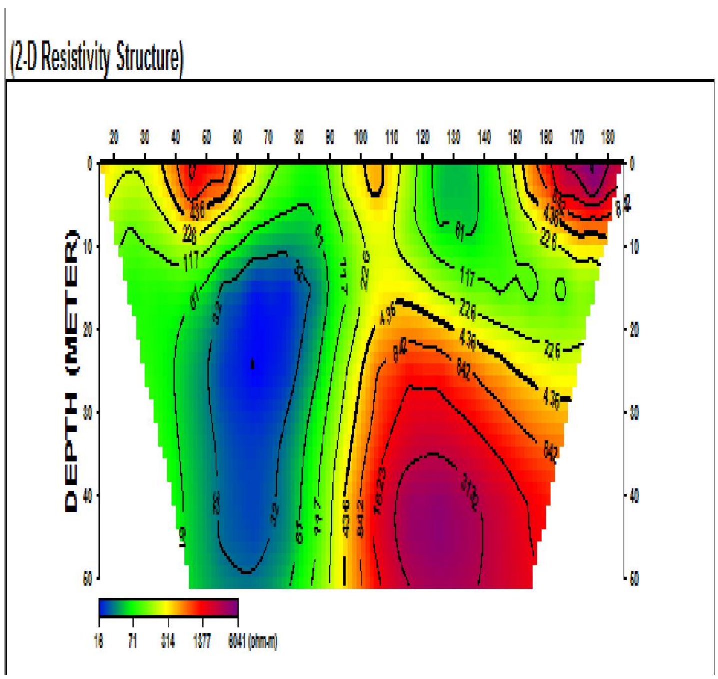


Figure 3.0;

The use of iteration software (Dippro) was used to interpret the data acquired through Wenner configuration. The computer iteration is represented below.

From the top soil at the depth of 0m to 0.7 m, the soil formation is covered with sand, sandy clay, clay, clayey sand and clay. It is shown that the distance 0m to 40 m along the profile is dominated by sand with resistivity of 226 Ωm, 40 m to 60 m is sandy clay with resistivity of 436 Ωm, 60 m to 65 m along the traverse is sand at resistivity with resistivity ranging from 226 Ωm to 436 Ω-m. From 65-95 m the sediment is dominated by clay at a resistivity ranging from 61Ωm to 117 Ωm, 95 m to 115 m along the profile is covered with sand sediment. At the distance of 115m to 150 m, the sediment is dominated by clay with resistivity ranging from 61Ωm to 117Ωm, Distance 150 m to 152 m is sand sediment with resistivity ranging from 226 Ωm to 436 Ωm,152 m to 162 m is sandy clay, 170 m to 180m is dominated by clayey sand.

At the depth of 0.7m to 10m, it is shown that the distance 20m to 30m along the profile has sediment of sand and clay with resistivity ranging from 117Ωm to 436Ωm, 30m to 35m is also dominated with sand and clay. Sand is gotten at the depth ranging from 0.7m to 5.4m with thickness of 4.7m and resistivity ranging from 226Ωm to 436Ωm. Beneath the sand is clay which has a depth of 5.4m to 10m.40m to 60m is covered by sandy clay, sand and clay with resistivity ranging from 117Ωm to 842Ωm.The sandy clay has a depth of 0.7-6m with resistivity of 436Ωm to 842Ωm.Beneath the sandy clay is sand which has a depth of 6m to 8m having thickness of 2m with resistivity of 226Ωm to 436Ωm and below the sand is clay with depth ranging from 7m to 10m with resistivity of 117Ωm to 226Ωm.60m to 95m along the traverse is dominated by sand and clay with resistivity ranging from 61Ωm to 436Ωm.Sand is gotten at the depth of 0.7m to 3m,below sand is clay which is at the depth of 3m to 10m.65m to 95m along the profile is dominated by clay with resistivity of 117Ωm to 226Ωm,95m to 115m is occupied by sand sediment at a resistivity of 226Ωm,the distance between 115m to 150m is dominated by clay with resistivity ranging from 61Ωm to 226Ωm.The distance 150m to 180m along the profile is covered with sand, sandy clay and clayey sand at a resistivity ranging from 226Ωm to 842Ωm.Sand is gotten at 150m to 152m along the profile at the depth from 0.7m to 8m.

At the depth of 10m to 21m, the soil formation is covered by sand, clay and pollutant. Distance 22m to 40m along the profile is dominated by clay with resistivity ranging from 61Ωm to 117Ωm, 40m to 100m is covered with clay and pollutant having a resistivity ranging from 32Ωm to 117Ωm, 100m to 175m is dominated by sand and clay with resistivity ranging from 61Ωm to 436Ωm.Sand can be reached at the depth of 10m to 21m with resistivity between 226Ω m to 436 Ωm along the distance 100 m to 115 m.

3.1 CONCLUSION

Based on the interpretation of geo-electrical data, VES indicates the presence of sand sediment (good water) with resistivity of 217.2Ωm in VES1,206.2Ωm in VES2, 308.4Ωm in VES3 and 308.7Ωm in VES4.It also reveals four geo-electric layers consisting of the surface layer(top soil), clay, sandy clay and sand.

Interpretation of the horizontal profiling also indicate the presence of sand sediment within the range of 226Ωm to 436Ωm. it is observed that VES is not so different from the Horizontal profiling, because both method gave depth, thickness and resistivity. So it cannot be said that one method is better than the other.

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